Big Picture..Strawperson

- Cavity fabrication
- Existing infrastructure in USA
- Strawman plan for SMTF modules

- Industrialization of cavity fabrication
  - Warren Funk

Review Goals/Strategies of SMTF

- Advance US regional SRF capability in anticipation of strong needs for ILC, RIA, Proton Driver, Light Sources…
- Gain experience to prepare us to develop a large-scale production plan, or to integrate with the evolving ILC production plan
- Use existing SRF infrastructure in many labs as much as possible (see next few slides)
- Integrate with DESY capabilities as much as possible.
- Integrate US industries from the start to develop US industrial capability for upcoming projects
- US industry personnel to use lab infra-structure (to save up-front investment cost)
- Work towards specific projects, e.g one ILC rf unit, by 2008, one cw rf module by 2007…
- Adopt a phased approach…there has to be lots of learning!

Existing Infrastructure Slides Few Examples From

- Jlab
- Cornell
- LANL
- MSU
- Fermilab
- Argonne
- SLAC (e-beam welder)
- AES (industrial)
  - Meyer Tool
  - Sciacky

JLAB

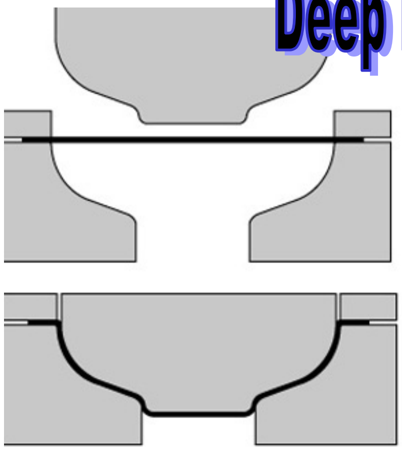
Cavity Vertical Test Areas

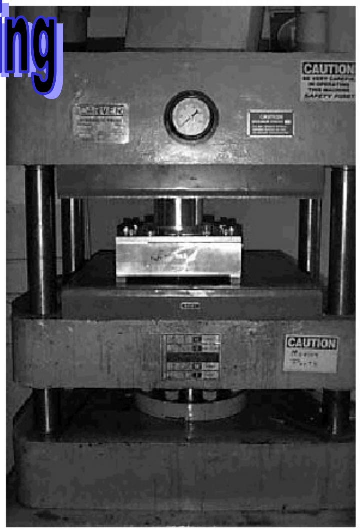
Jlab - Cryomodule Assembly and Test Areas

Cryomodule Test Facility (CMTF)

SRF Infrastructure

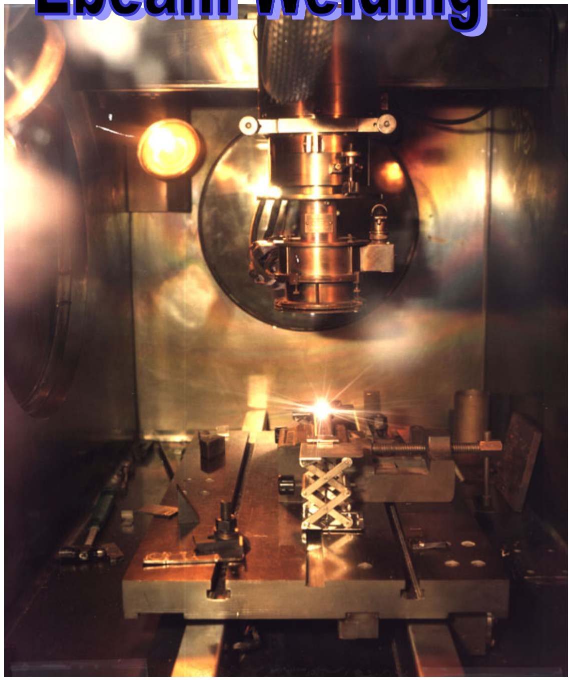
Deep Drawing



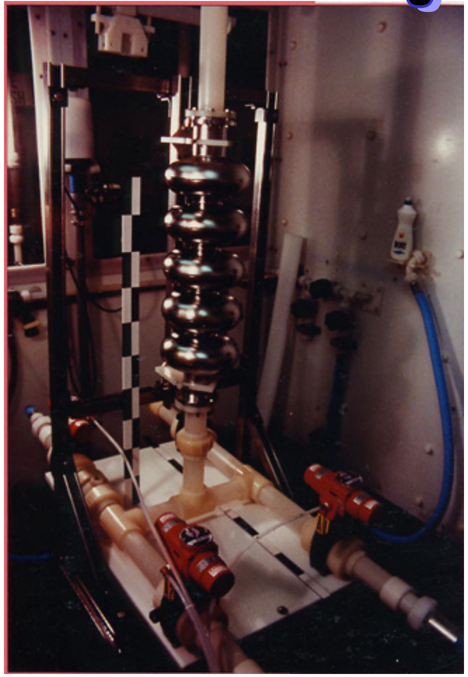


1000 Sq Ft Clean Room

Ebeam Welding



Chemical Etching



High Pressure Rinsing

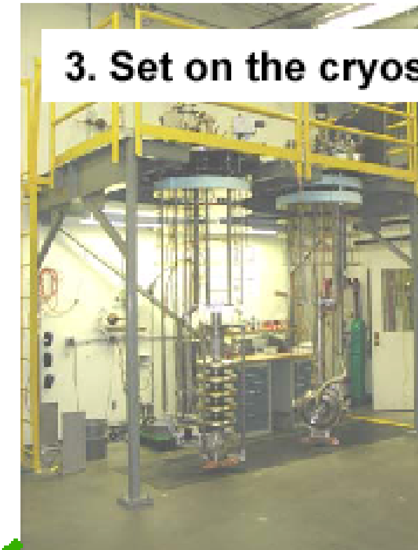
Cornell Cavity Test Pits

Los Alamos Nat Lab - SRF Facilities

2. Assembly with flanges, couplers, valves, etc. in a 2600 ft^2 Clean room

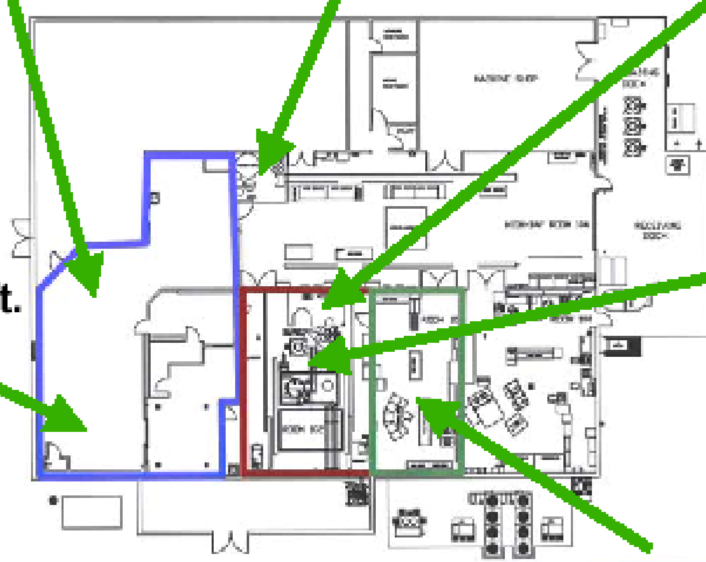
1. Ultra-pure water is used for HPR and assembly.

3. Set on the cryostat inser



140 ft.

100 ft.



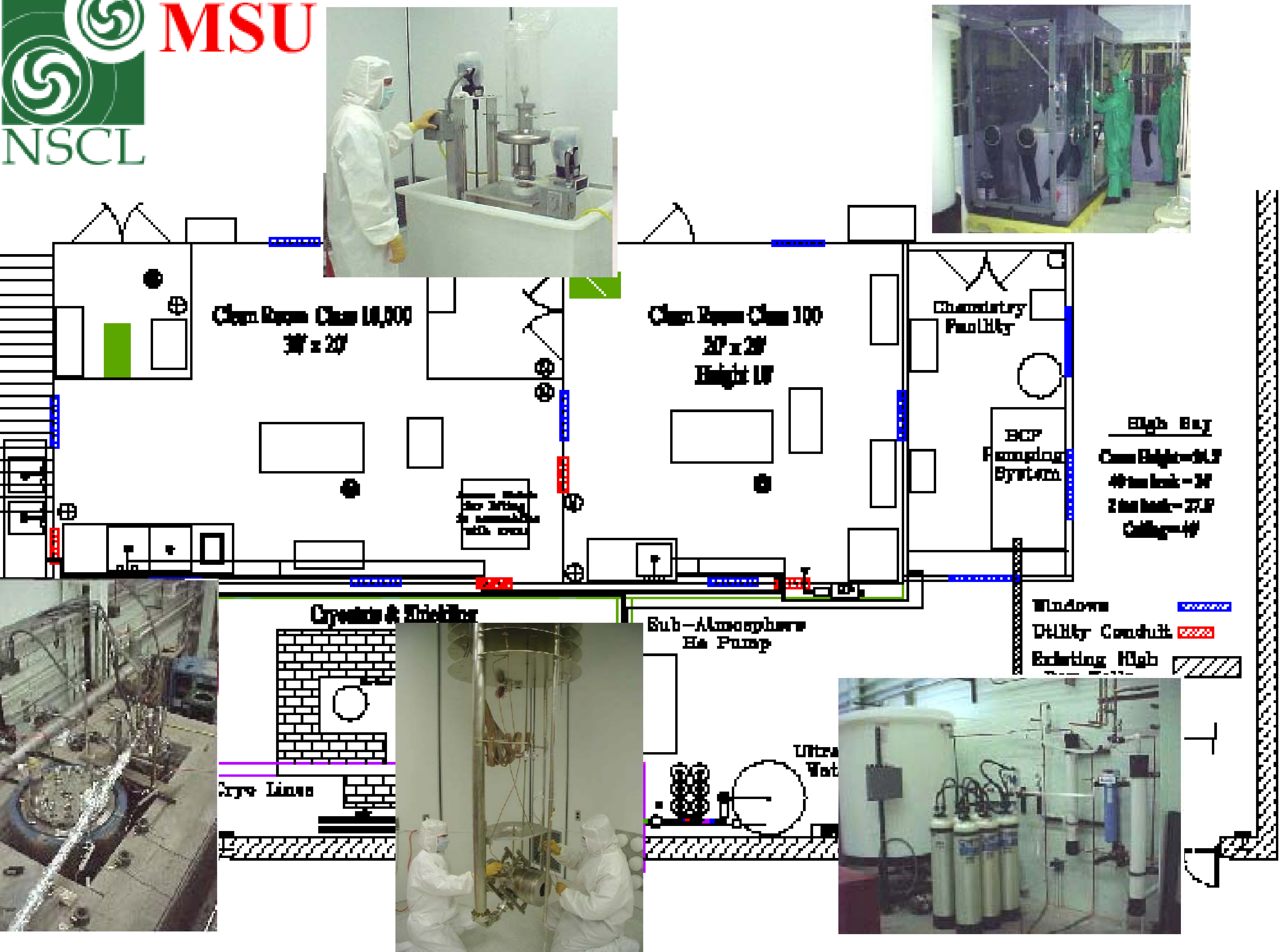
4. Inserted in a 38” cryostat with radiation shield

High-pressure rinsed in a clean room.

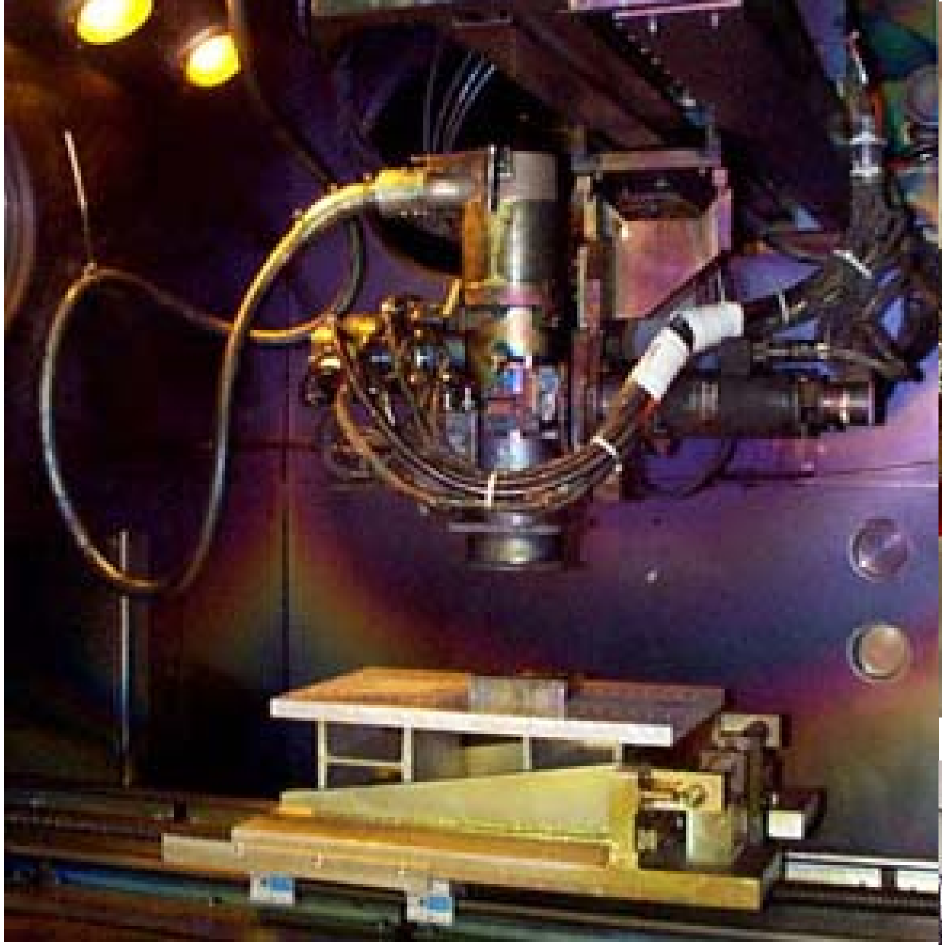
Control, tuning

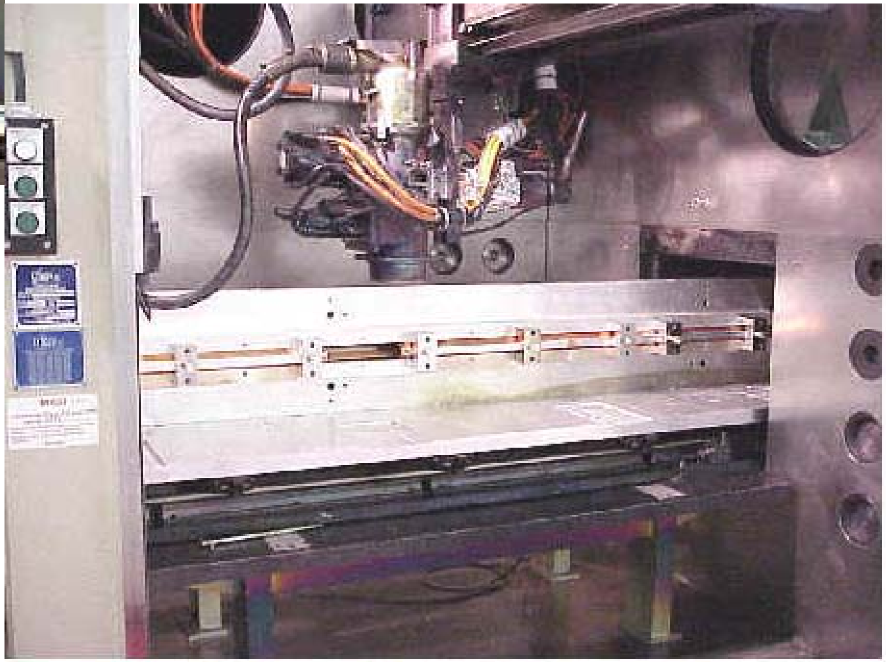
MSU

NSCL



Clean Room Class 10,000
Clean Room Class 100
Chemistry Facility
BCP Pumping System
High Bay
Sub-Atmosphere He Pump
Cryo Lines
Windows
Utility Conduit





SLAC

S/C FIVE (5) CELL CAVITY-700MHz RRR250

Advanced Energy Systems, Inc.

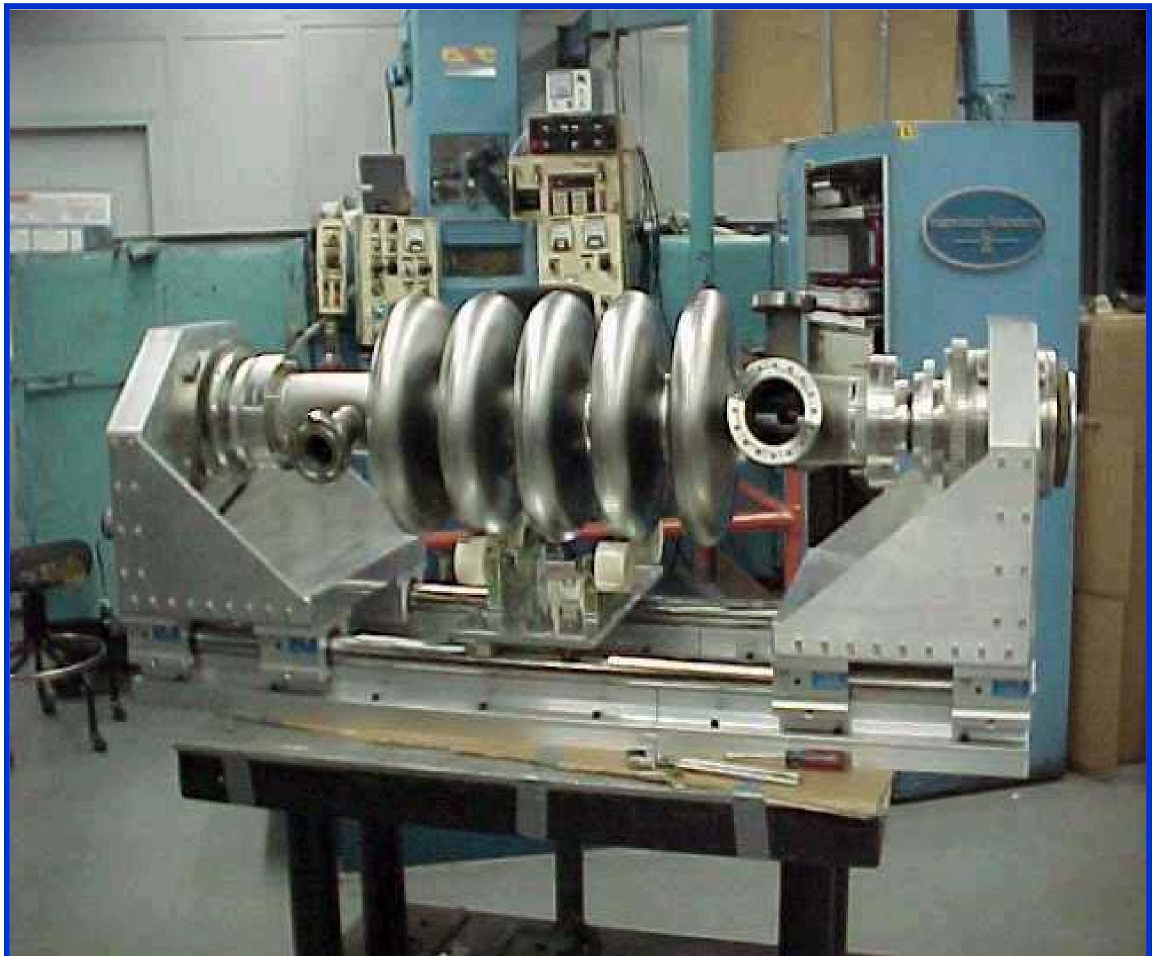
Putting Accelerator Technology to Work

In US

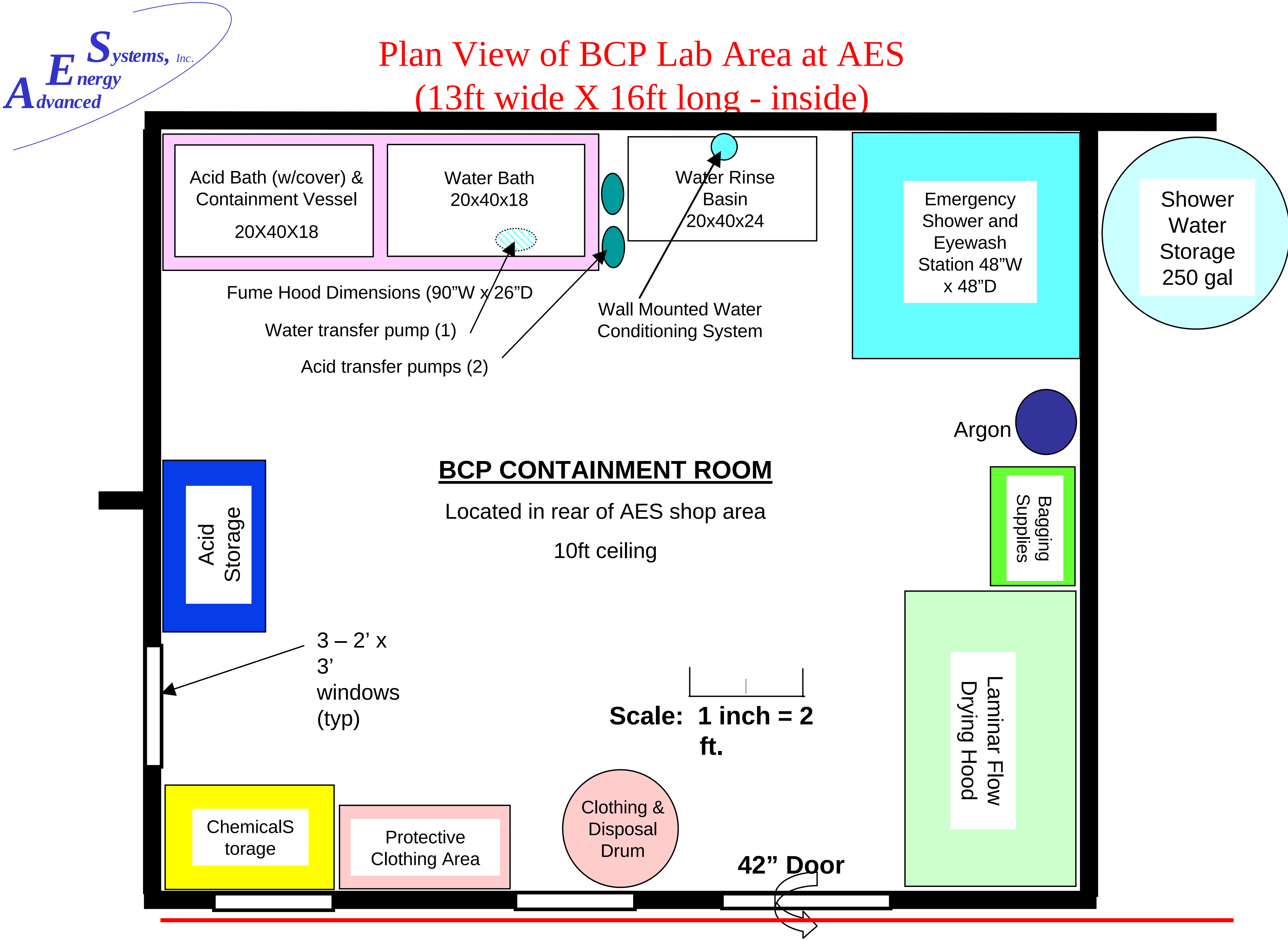
APT, LANL

Fermilab, 3.9 GHz

BNL 700 MHz



Plan View of BCP Lab Area at AES
(13ft wide X 16ft long - inside)



Goals for CW SCRF

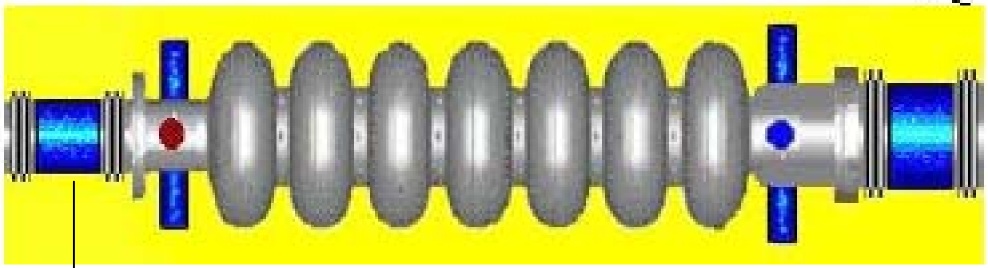
- Common R&D interests across many CW SRF proposals are:
- Demonstrate 20 MV/m CW operations at Q values > $3x10^{10}$.
- Operate at 20 MV/m at a $Q_{ext} > 1x10^7$ for low beam loading applications.
- Address the following major issues for CW operation and high current:
- Thermal management
- HOM damping
- Cavity tuning control
- Power coupler designs

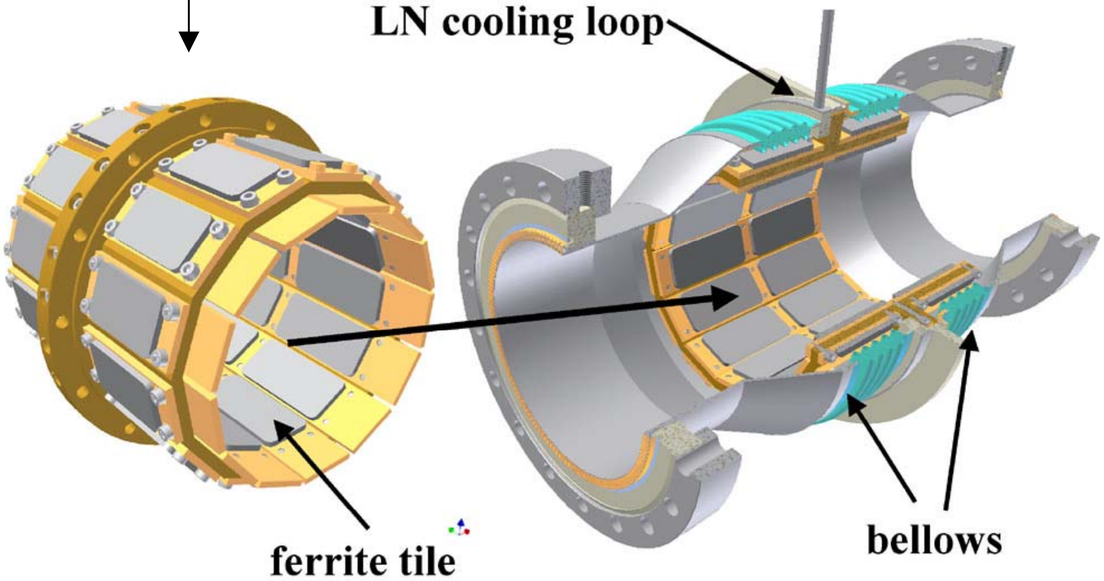
Several RF Structures Under Development Already to Address Similar Issues

- At different frequencies and with different parameters
  - Cornell is conducting a study towards 7-cell, 1300 MHz cavities with beam pipe HOM couplers good for 100 mA beam current, and for frequencies up to 40 GHz
- A high-current ERL prototype is under construction at BNL. The objective is to demonstrate 0.5 ampere CW current at about 20 MeV. (R&D towards electron cooling of RHICA
- Jlab upgrade module (Renassance)

Cornell

7-cell, large beam pipe, 1.3 GHz

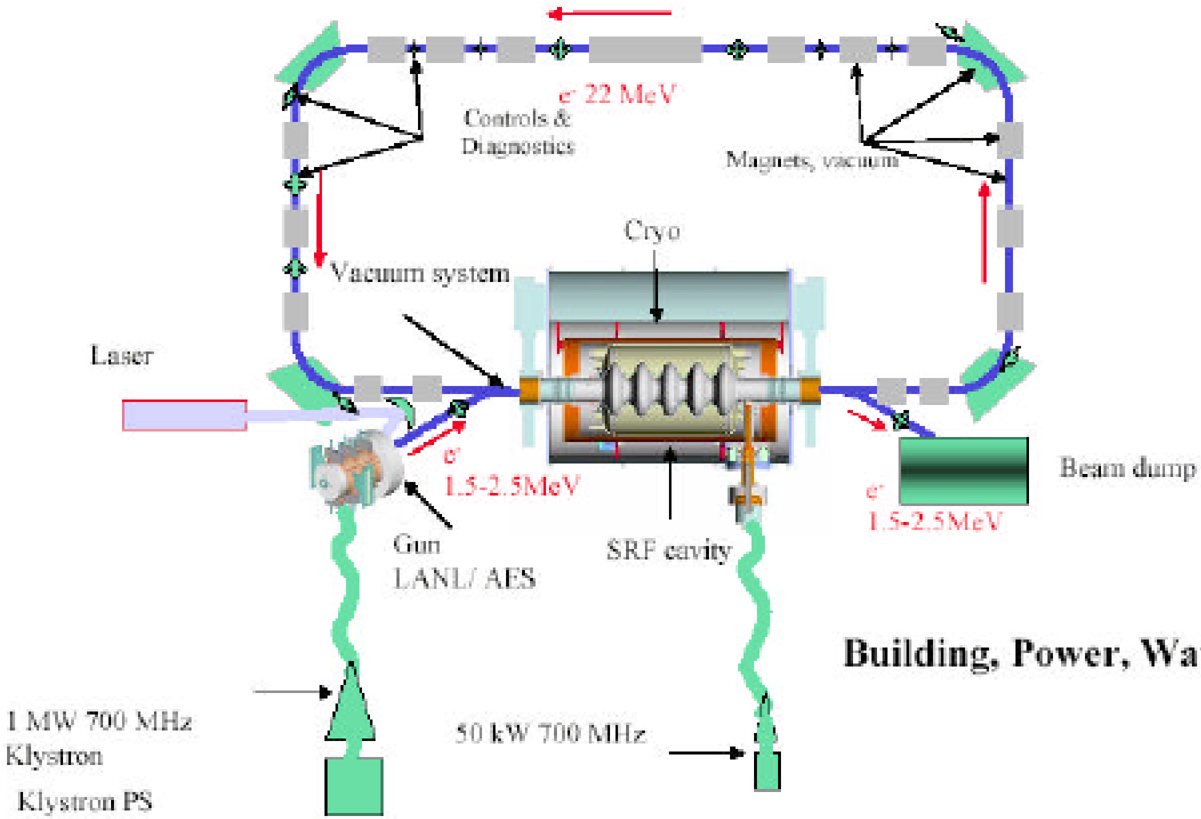




HOM couplers inside cryomodule

200 watts

A Complete ERL for R&D

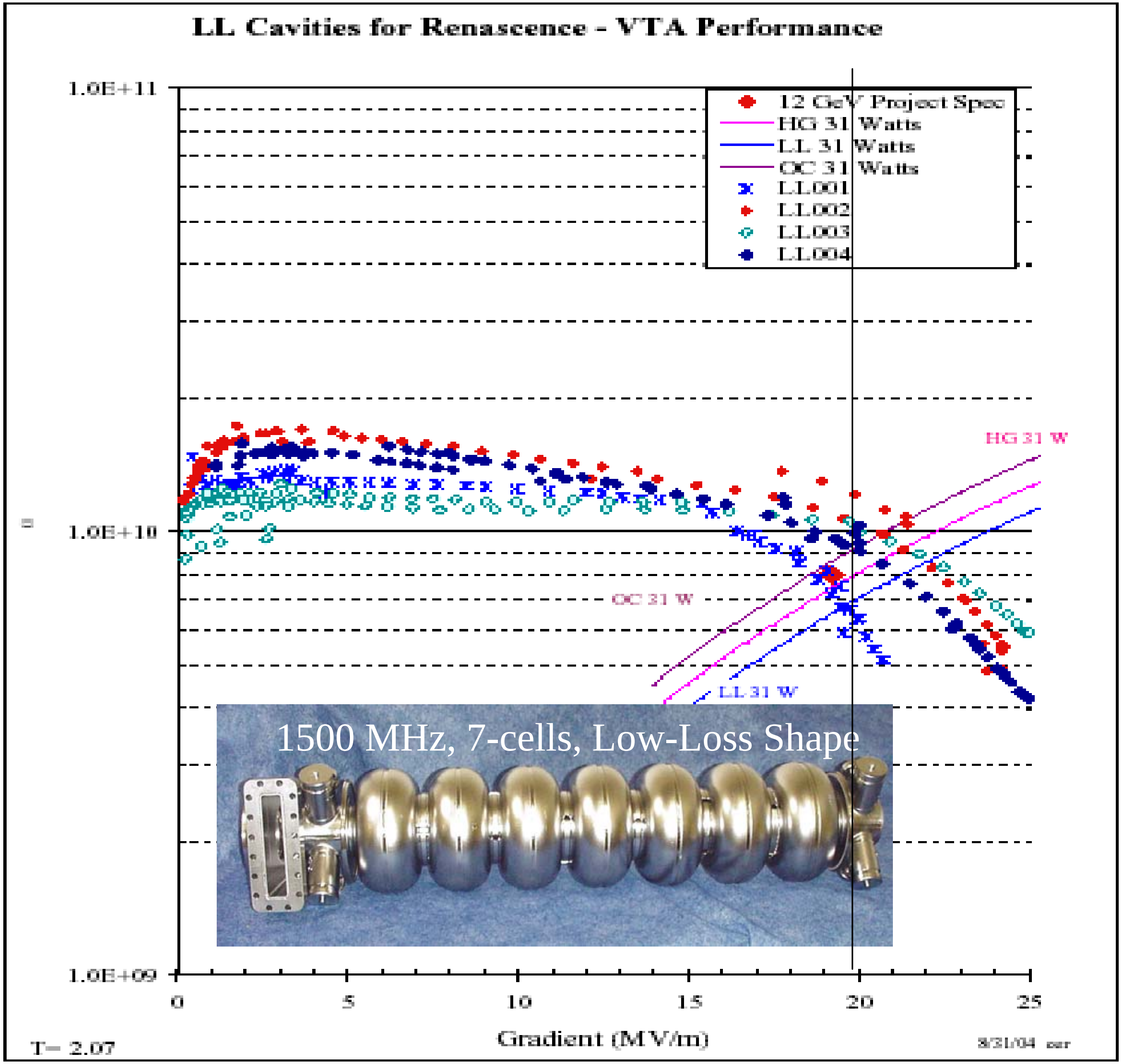


Building, Power, Water…

Prototype

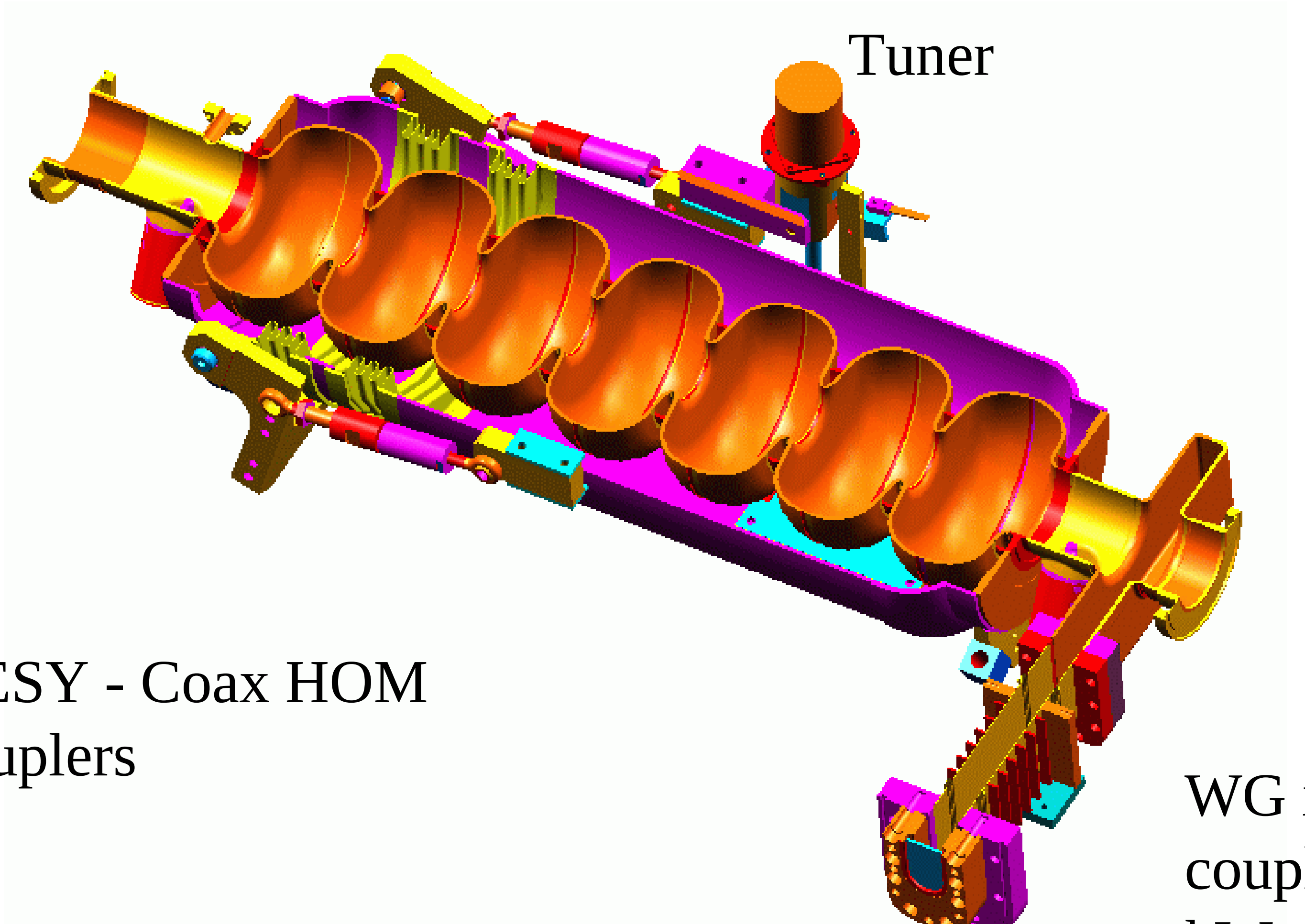
Jlab- Renascence

- Cavity designs for application to CEBAF 12 GeV Upgrade
- Design operating temperature: 2.09 K at cavities
  - 250 W dynamic loss per cryomodule
  - 31 W per cavity
  - 44 W per active meter
  - 460 μA CW beam

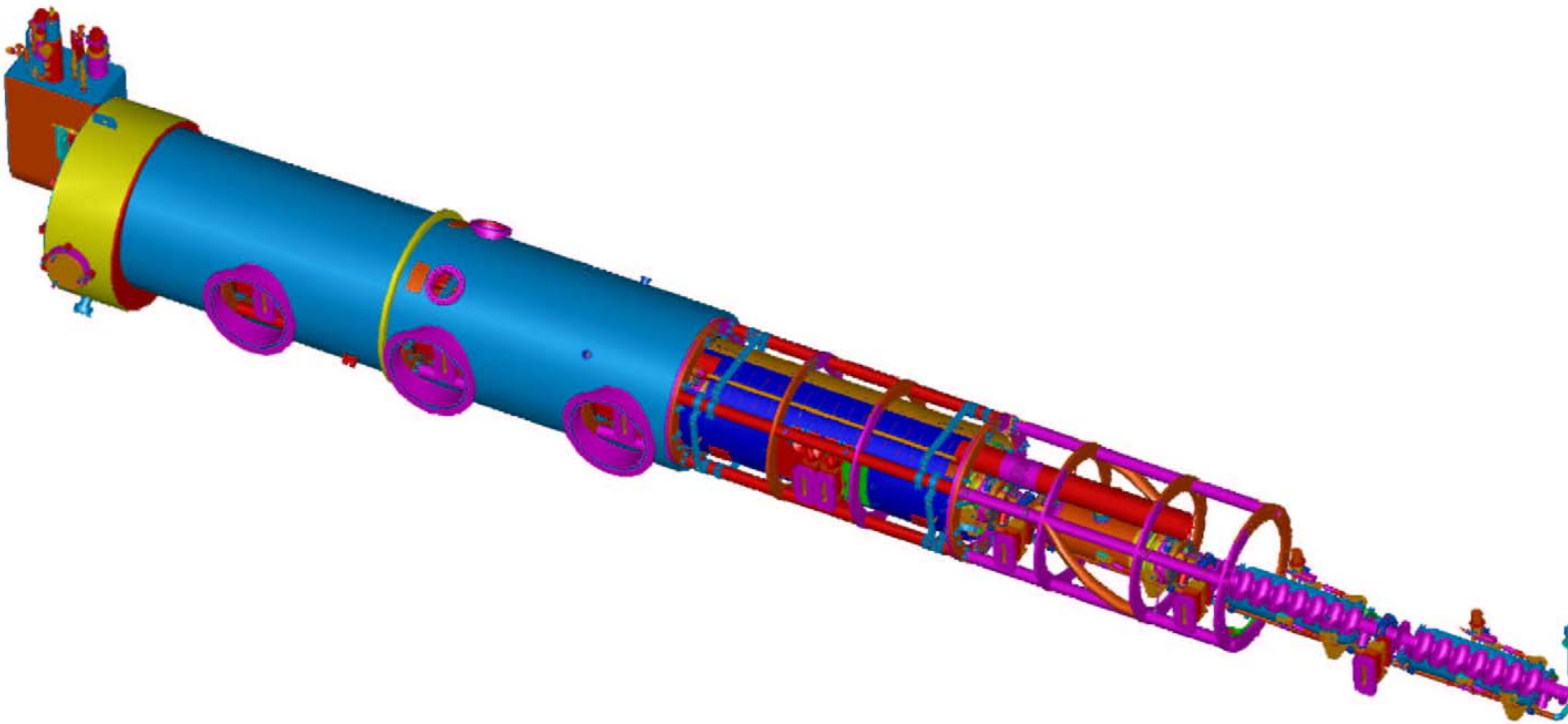


LL Cavities for Renascence - VTA Performance
1.0E+11
1.0E+10
1.0E+09
12 GeV Project Spec
HG 31 Watts
LL 31 Watts
OC 31 Watts
LL001
LL002
LL003
LL004
HG 31 W
OC 31 W
LL 31 W
1500 MHz, 7-cells, Low-Loss Shape
0
5
10
15
20
25
Gradient (MV/m)
T= 2.07
8/31/04 ear

LL Cavity System



Renascence Cryomodule



Example SMTF Scenario: 20 MV/m, for the CW unit for high current, high Q amd high Qext

- Design “common denominator module” for CW operation
- Identify subassemblies to be prototyped, e.g cavity/coupler assembly
- Build Prototype subassemblies with industrial collaboration (see ILC example for more)
- Test prototype subassemblies at lab
- Consider design/process optimizations before launching production for all components of one full module
- Build one module following scenario similar to ILC module (with industry)
- Test at SMTF
- Beam test at SMTF

Example ILC-Related goal

- Adopt a phased approach toward performance goals
- Start with existing design/process
- Adopt all techniques necessary to aim towards 35 MV/m, Q = 10^{10}
- Build first module in “learning mode” with industrial collaboration
- Determine “learning-mode” performance..(OK to be < 35 MV/m)
- Identify areas where improvements are needed
- Install design/process optimizations before launching next 3 modules
- Build 4 + modules
- Test modules at SMTF
- Beam test modules at SMTF

Strawman Plan for Cavity/He Vessel/Cavity String…

- Planning/Definition
  - Form co-ordinating group (ILC involvement)
  - Define first "module from DESY" based on discussions with DESY, others (TTF-like)
  - Obtain first SMTF module from DESY (provide help)
  - Obtain designs from DESY, obtain procedures from DESY
  - Get up to speed on processing…(e.g process 9-cell cavities)
- Plan first US SMTF module = same as first DESY SMTF module (TTF-like)

Strawman Plan for Cavity/He Vessel/Cavity String…

- Make cavity parts, clean cavity parts
- Weld cavity
- Field flatness tuning
- Heat treatment (“800” C or 1400 C as determined best)
  - Could also be done at half-cell stage, proven to reach 35 MV/m in single cells at Cornell
- Electropolishing, high pressure rinse
- Vertical acceptance test
- Weld He vessel, re-measure field flatness
- High pressure rinse
- Attach input coupler, tuner…(see later slides)
- Individual cavity/coupler/tuner assembly tests at high power (like CHECHIA)
- Cavity/coupler assembly ready for string assembly

- Measurements and Quality control for all steps above

Cavity Fabrication Facilities Locations

- Parts fabrication, eg deep drawing
  - AES, Meyer Tool…
  - (Jlab, Cornell, LANL, FNAL, if needed)
- Parts chemistry
  - AES..
  - Jlab, Cornell, LANL, FNAL…
- Sub-assembly e-beam welding
  - Sciacky…
  - Jlab, Cornell, SLAC, LANL
- Final Welding
- Heat treatment
  - Cornell, Jlab
- Chemical etching
  - Jlab, Cornell, Argonne/FNAL..
- Electropolishing
  - Jlab
- HPR
  - Jlab, Cornell, LANL, MSU, FNAL
- Tuning
  - Jlab, Cornell, LANL
- Vertical Test
  - Jlab, Cornell, LANL

- Weld helium vessel
- Check field profile
- HPR
- Send to string assembly location
- ….

Input Coupler Scenario

- Order input couplers from CPI or AMAC…
- Set up high power coupler test facility with RF power
  - Possible locations: Jlab, LANL, Fermilab
- Assemble/bake high power couplers
- High power test
- Send to cavity string assembly location

Tuner Scenario

- Select tuner design
- Carry out further engineering necessary
- Order tuner parts
- Assemble tuners at cavity assembly test facility

Cavity String Preparation

- Receive cavity/He vessel/input coupler/tuner
- Assemble and test (like-CHECHIA)
- Send to string assembly location

- Receive other vacuum and alignment parts
- Set up and align clean room string support structure
- Assemble cavity string
- Align cavity string
- Fix bellows
- Leak test
- SC quads (chose the design, get specs)
- Infrastructure needed assuming SMTF location:
  - Large clean room with string support structure
  - high pressure rinsing

Time Estimate for Experienced People
From Fermilab Engineering Study

AT DESY
The preparation labor for each cavity is about 185 man-hours prior to assembly into a string. This includes chemistry, tuning, and oven bake out.

Multiplying by 8 cavities, this gives 185 man-days per cryomodule for this cavity prep work.

The assembly of the TTF cavity string takes about 15 man-days. The assembly of the string into the module takes approximately 60-80 man-days (see below).

This totals ~270 man-days ~1.1 man-year.

SMTF first module will take much longer, of course